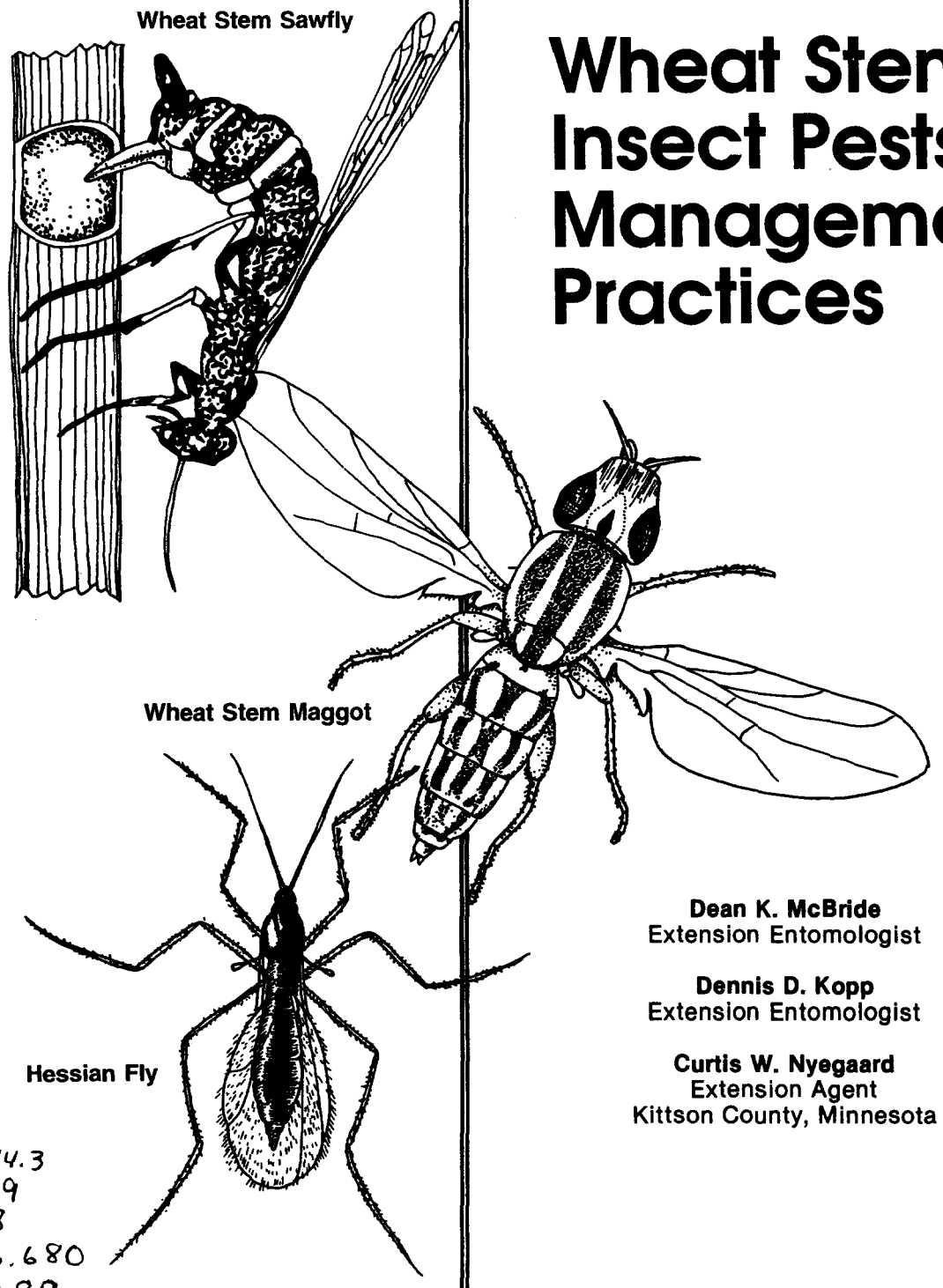
E-680 (Revised)

Wheat Stem Sawfly

Wheat Stem Insect Pests and Management Practices



Wheat Stem Maggot

Hessian Fly

Dean K. McBride
Extension Entomologist

Dennis D. Kopp
Extension Entomologist

Curtis W. Nyegaard
Extension Agent
Kittson County, Minnesota

NDSU EXTENSION SERVICE
North Dakota State University, Fargo, ND 58105

APRIL 1989

INTRODUCTION

Three insects, the wheat stem sawfly, wheat stem maggot, and the Hessian fly, are important pests of wheat in North Dakota.

The wheat stem sawfly is native to the hollow stemmed grasses of western North America. The sawfly readily adapted to wheat, especially spring wheat, when it replaced most of the sawfly's native hosts in the Northern Great Plains. Today, wheat is the major host plant in North Dakota. The most obvious damage caused by the sawfly is the breaking over of stems that have been weakened by larval tunneling.

The wheat stem maggot is also a native insect that can be found from eastern North America across the prairie provinces of Canada and south to Mexico. Before wheat was brought to North America, the wheat stem maggot attacked native grasses. Damage in wheat becomes evident after flowering and infected stems die and turn white.

The Hessian fly was probably brought to America from Europe in straw used by soldiers as bedding during the Revolutionary War. By 1898, it had spread from Long Island, New York, to most eastern and midwestern wheat growing areas and to areas of the Pacific Coast. The Hessian fly causes stunting in seedlings plantings and lodging as wheat matures.

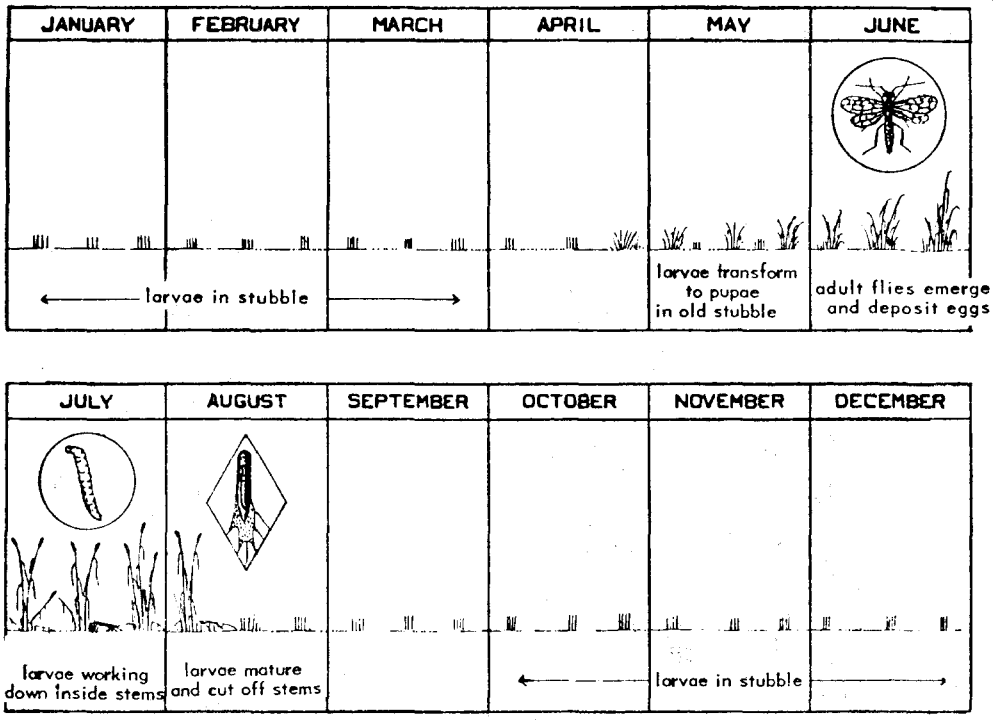


Figure 1. Diagram of Life History of the Wheat Stem Sawfly.

Wheat Stem Sawfly

HISTORY

The sawfly was first found mining the stems of native grasses in 1890 in California. In 1895, adults were collected in the Canadian Northwest Territories, and larvae were found feeding in wheat stems in Manitoba. In 1906 larvae were found attacking wheat in south-central North Dakota. By 1909 losses of 5 to 25 percent were reported in the area around Minot and in the Red River Valley near Fargo. The North Dakota infestation reached epidemic proportions in 1916, but receded rapidly, and by the early 1920s the sawfly was a pest of slight importance. From 1940 to the mid-40s the sawfly again became a problem with as much as 50 percent crop loss reported in northwestern North Dakota.

Through cultural control practices, wheat stem sawfly damage has been held to a minimum in North Dakota from the mid-1940s to date. However, each year the sawfly takes its toll, primarily in western North Dakota.

LIFE HISTORY (Figure 1)

A mature larva overwinters within a wheat stub below the surface of the soil. In the spring the larva transforms to a pupa inside the stub and the adult emerges in early June (Figure 1). The female will deposit a single egg per stem with a preference for the growing interstem. Plants in the stem elongation to boot stage are favored for egg laying. After the egg hatches into a larva, it feeds inside the stem until late summer. As the plant starts to mature, more light penetrates the stem, causing the larva to move downward and away from the light until it reaches the lower parts of the plant close to the surface of the ground. Here the larva cuts a V-shaped groove around and inside the stem and plugs the stub with its body wastes (Figure 2) forming a chamber in which it hibernates and pupates the following May.

DAMAGE

Sawfly damage is threefold. First, they cause 10 to 14 percent grain yield reduction by their tunneling activity in the infested stems. Additional loss occurs when sawfly-cut stems fall to the ground and become unharvestable. The protein content of grain from the infested stems is also lower.

DESCRIPTION

When mature, the sawfly larva measures ½ inch or longer, and is

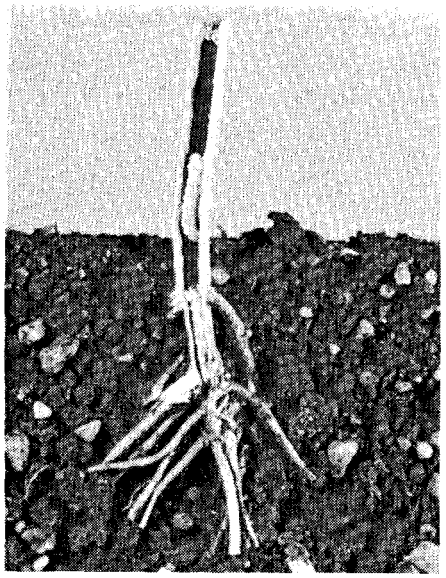


Figure 2. Sawfly larva in stem (note frass plug - arrow).

pale white or yellowish in color, with a well-defined head (Figure 3).

The adult sawfly is a slender wasp about ½ inch long with a black abdomen with yellow ringed markings (Figure 4). When observed in the field, sawflies may be recognized by the unusual habit of resting head downward on the stems of grain plants.

The present understanding of the dynamics of wheat stem sawfly populations does not allow prediction of the population next season based on stubble infestations. Research is continuing in this area and improved predictability related to field populations are a realistic future goal. At present, the decision to manage wheat production for sawfly cutting is based on the history of previous loss due to this pest. If a wheat grower has observed an increasing loss from sawflies, management options include resistant varieties, rotations with non-susceptible crops, delayed planting of susceptible varieties, and shallow fall tillage.

SAWFLY RESISTANT VARIETIES

Use of resistant varieties of wheat reduces the severity of sawfly damage. Solidness of the lower three internodes of the stem accounts for sawfly resistance in wheat. Susceptible varieties have hollow internodes; however, certain weather conditions may influence stem solidness. The sawfly resistant hard red spring varieties include: Cutless, Glenman, Leader, Lew, Tioga, and Fortuna. The information used to describe the six varieties is based on the quality classifications system established by the North Dakota State University Department of Cereal Science.

Figure 3. The wheat stem sawfly: mature larva. Enlarged.

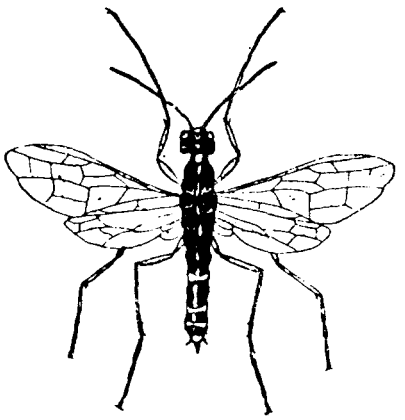


Figure 4. Adult wheat stem sawfly, *Cephus cinctus*. Much enlarged.

Cutless

Cutless was released by the North Dakota Agricultural Experiment Station in 1986. Cutless is a semidwarf with average yield. It has medium straw strength, medium early maturity, is resistant to stem and leaf rust, has a high test weight and protein content and a good quality rating.

Glenman

The Montana Agricultural Experiment Station released Glenman in 1984. It is a semidwarf of above average yield. It has strong straw strength, medium maturity, is resistant to stem rust, is moderately susceptible to leaf rust, has an average test weight, and a low protein rating with a very poor quality rating.

Leader

Leader was released by Canada in 1982. Leader is a standard height variety with average yield. It has medium straw strength, medium maturity, is resistant to stem rust, is moderately susceptible to leaf rust, has a high test weight and protein content with a good quality rating.

Lew

Lew was released jointly by the agricultural experiment stations of Montana and North Dakota in conjunction with the Agricultural Research Service in 1976. Lew is a standard height variety with average to above average yield. It has medium straw strength, medium maturity, is resistant to stem rust, stripe rust and loose smut, is moderately susceptible to leaf rust, has a high test weight, an average protein rating, and an average quality rating.

Tioga

Tioga was released jointly by the North Dakota Agricultural Experiment Station and the Agricultural Research Service in 1974. Tioga is a standard height variety with below average yield. It has medium strong straw strength, medium maturity, is susceptible to both stem and leaf rust, is resistant to black chaff, has average test weight, and has a high protein rating with a good quality rating.

Fortuna

Fortuna, a standard height variety with below average yield, was released jointly by the agricultural experiment stations of North Dakota and Montana and the Crops and Entomology Divisions, Agricultural Research Service, USDA, in 1966. Fortuna has weak straw strength, medium early maturity, is susceptible to black chaff, is resistant to stem rust, is moderately susceptible to leaf rust, has average test weight, and has low protein content with an average quality rating.

Lancer

Lancer was released by Agriculture Canada in 1985. Lancer is a conventional height, awnless variety with a heading date similar to Len and Lew. In North Dakota tests, Lancer is lodging susceptible, has a leaf spotting disease rating similar to Lew and is moderately susceptible to leaf rust and resistant to stem rust. It has a satisfactory test weight but a lower yield potential, less than Cutless and other solid stem wheats. Canadian data indicate that Lancer yields similar to Leader but has a more solid stem and is more resistant to shattering and common root rot than Leader.

CROP ROTATION

Sawfly damage has been most severe in fields which are continuously cropped to hard red spring wheat and where stubble is left undisturbed. Sawflies emerging from the previous year's stubble can infest wheat in the same or adjacent fields. Therefore, the use of nonhost crops should be considered in these areas.

Sawflies do not damage oats, flax, mustard, sunflower, safflower, and legumes. Other crops that are susceptible but only allow a small number of larvae to survive are winter wheat, durum wheat, barley and winter rye. Winter wheat will usually mature before the sawfly has time to complete its development and is too far along to be attractive for egg laying.

DELAYED PLANTING

The practice of planting spring wheat after May 20 will reduce sawfly damage if a susceptible variety is to be planted, but a reduced yield can be expected because of the late planting date with all varieties. If bad weather delays planting until after May 20, a high yield sawfly susceptible variety should be selected since the crop will escape sawfly damage.

TILLAGE

Tillage offers a management option for fields that have had moderate to high damage due to wheat stem sawfly. Research has demonstrated that shallow fall tillage will provide up to 90 percent sawfly control. If only spring tillage is used, about 25 percent of the larvae may be killed, depending on the type of tillage used. Shallow tillage should dislodge stubble so the larvae in the stubble will be exposed.

NATURAL CONTROL

At least four different wasps have been found to parasitize the sawfly. However, they do not normally kill enough sawflies to prevent damage to wheat fields. The only time parasitism seems to have a significant effect on the sawfly population is when weather conditions delay the ripening of the crop for two consecutive years.

CHEMICAL

At the present time, no effective chemical treatment is available.

Wheat Stem Maggot

LIFE HISTORY (Figure 5)

Wheat stem maggots overwinter in the larval stage, inside the lower parts of grass stems. In the spring, the larvae pupate and adults emerge in June. The adults are yellowish-white flies, about 1/5 inch

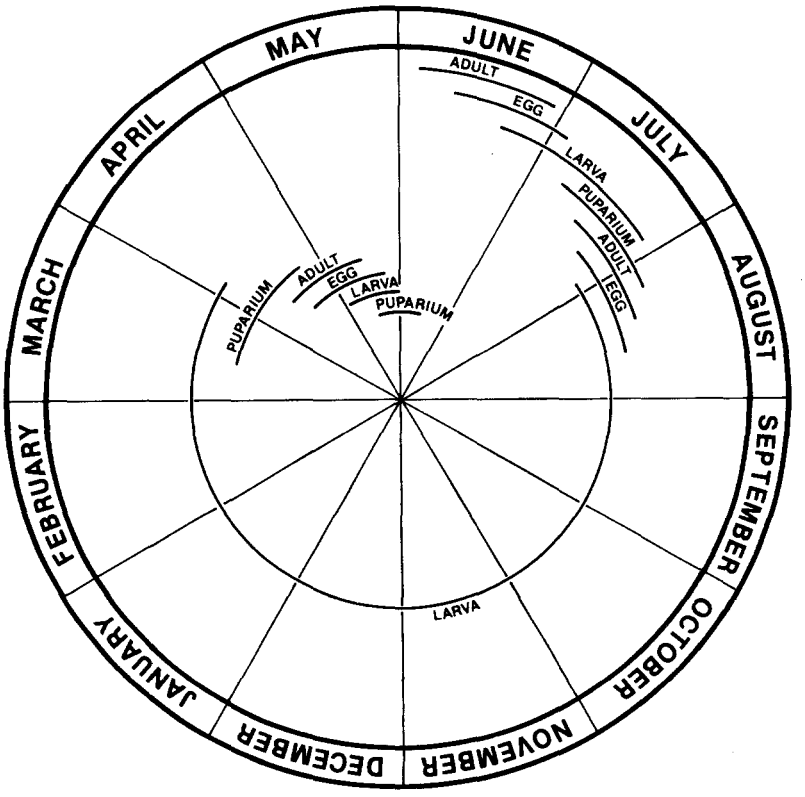


Figure 5. Life cycle of the wheat stem maggot. (Modified from Allen and Painter 1937).

long, with three conspicuous black stripes on the thorax and abdomen and bright green eyes (Figure 6). After mating, females deposit their eggs on the leaves or stems of grasses. The young maggot crawls down beneath a leaf sheath and tunnels into the stem. The stem is partially severed causing the head to turn white. The head and terminal straw of maggot-infested wheat will pull out easily due to the internal chewing damage by the larvae. The larva pupates within a cigar-shaped, pale green puparium. The adults emerge about midsummer and lay their eggs on wild grasses or volunteer grain. The resulting larvae overwinter in the stems of the wild grasses and volunteer grain.

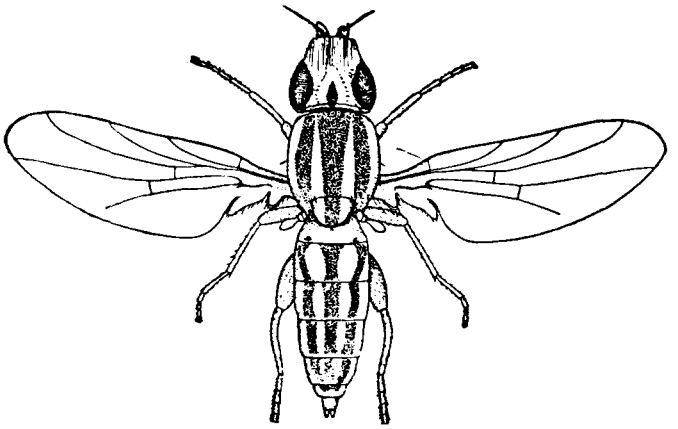


Figure 6. The wheat stem maggot, *Meromyza americana* adult; 11 times natural size.

DAMAGE

The wheat stem maggot damage becomes evident after flowering when seeds begin to develop. Normally the first indication of its presence is the dying and whitening of the wheat heads and upper internodes (Figure 7) while the lower stem and leaves remain green. A single maggot will be found inside the straw just above the last node (Figure 8). The plant stem pulls out very easily and if larvae are not found, the stem is usually cut off. Infestation levels rarely exceed 2 percent, but occasionally may be somewhat higher.

The presence of white heads alone is not always an accurate assessment of damage. The maggots can also intest young tillers prior to the boot stage causing the affected tiller to abort. These aborted tillers can account for an unseen loss in yield.

The principal cultivated crop hosts of the wheat stem maggot are wheat (bread and durum), rye and barley, with wheat being preferred. It also attacks bluegrass, timothy, quackgrass, slender and western wheat grass, wild barley, bromegrass, green and yellow foxtail and bluestem grass.

Figure 7. White head symptom of wheat stem maggot on right, compared to a normal wheat head on left.

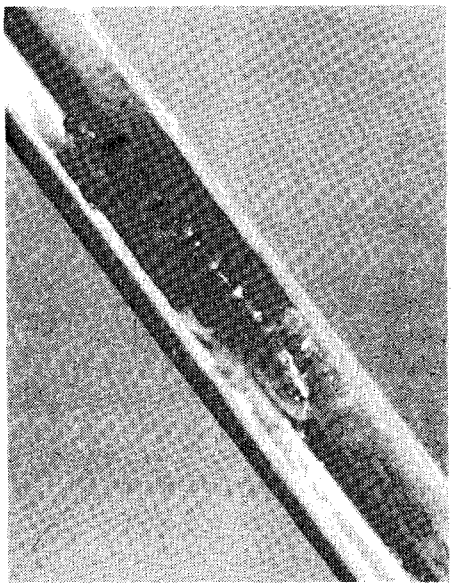


Figure 8. Larva of wheat stem maggot and typical damage that occurs above the top node of the stem, causing white heads.

Management

RESISTANT VARIETIES

At present, no wheat varieties have resistance but research indicates that late maturing varieties suffer less damage than early maturing varieties.

CROP ROTATION

Rotation with non-susceptible crops such as corn, sunflowers, flax, soybeans, safflower or legumes will reduce the numbers of this pest.

TILLAGE

Plowing under volunteer grain will reduce populations of this insect.

NATURAL CONTROL

Several parasites attack the wheat stem maggot but control is not consistent enough to provide reliable annual control.

CHEMICAL

No effective chemical treatment is available.

Hessian Fly

LIFE HISTORY (Figure 12)

The Hessian fly overwinters as a full-grown maggot in the prepupal ("flaxseed") stage in stubble, volunteer spring wheat, and early seeded winter wheat. Maggots pupate in early spring and adult flies emerge from April to May. The flies are sooty-black, much smaller than a mosquito (Figure 9), and are very fragile. They cannot fly very far but may be carried considerable distances by wind.

The abdomens of females are orange-red and lay reddish eggs in the grooves on the upper sides of the wheat leaves (Figure 10). The females can deposit up to 300 eggs and can only live three to four days.

DAMAGE

The type of injury caused by the Hessian fly is not conspicuous and is easily overlooked. Hard red spring wheat infested in the spring and early summer will take on a dark bluish-green color and become distinctly thickened and stunted. The central growing shoot is often absent. Small white or greenish-white, shiny, legless and head-less maggots about 3/16 inch long (Figure 11) or brown puparia (capsule-like cases often called flaxseed) that contain white maggots and are about 1/8 inch long will be found beneath the sheaths of the lower leaves of the plant sometimes as high as the second or third joints. The most conspicuous injury is the breaking over of infested stems when the heads begin to fill (Figure 12, June and July). Heavily infested fields can have as high as 75 percent of the straws broken.

Figure 10. Eggs of the Hessian fly. Much enlarged.

The injury is caused by the larvae, which withdraw sap from the lower parts of the stem for a period of seven to 14 days. However, the larvae cause little apparent physical plant tissue damage. The injury is caused by a toxic salivary secretion into the plant which interferes with metabolism and growth. Infested tillers are less than half the size of noninfested healthy tillers. Stunted tillers, especially in younger plants, wither and die. If they survive, the growth and yield will be reduced. Second brood infestations usually cause poorly filled heads with fewer kernels and lower test weight.

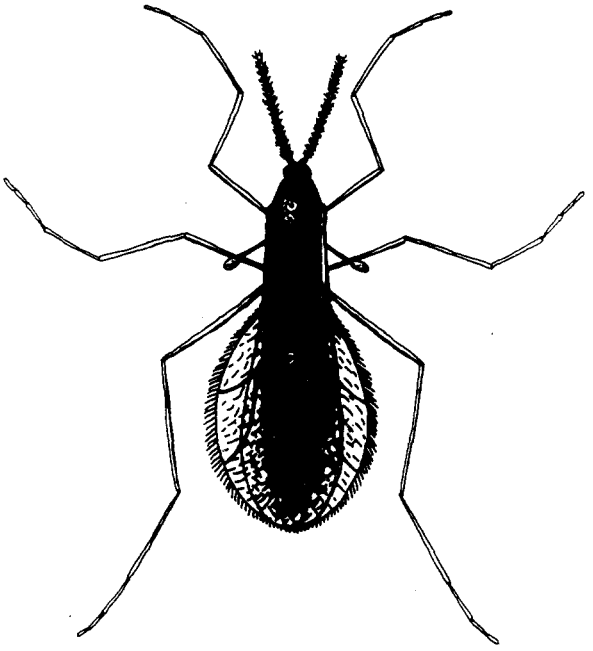


Figure 9. Hessian fly - female, *Mayetiola destructor*. Enlarged.

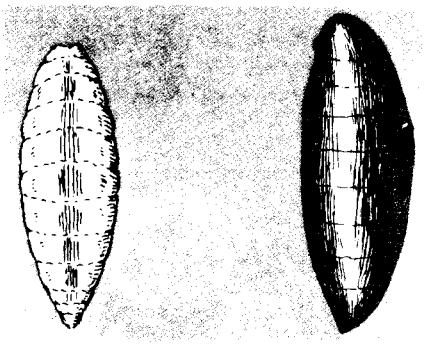


Figure 11. Larva (left) and flaxseed of the Hessian fly. Enlarged.

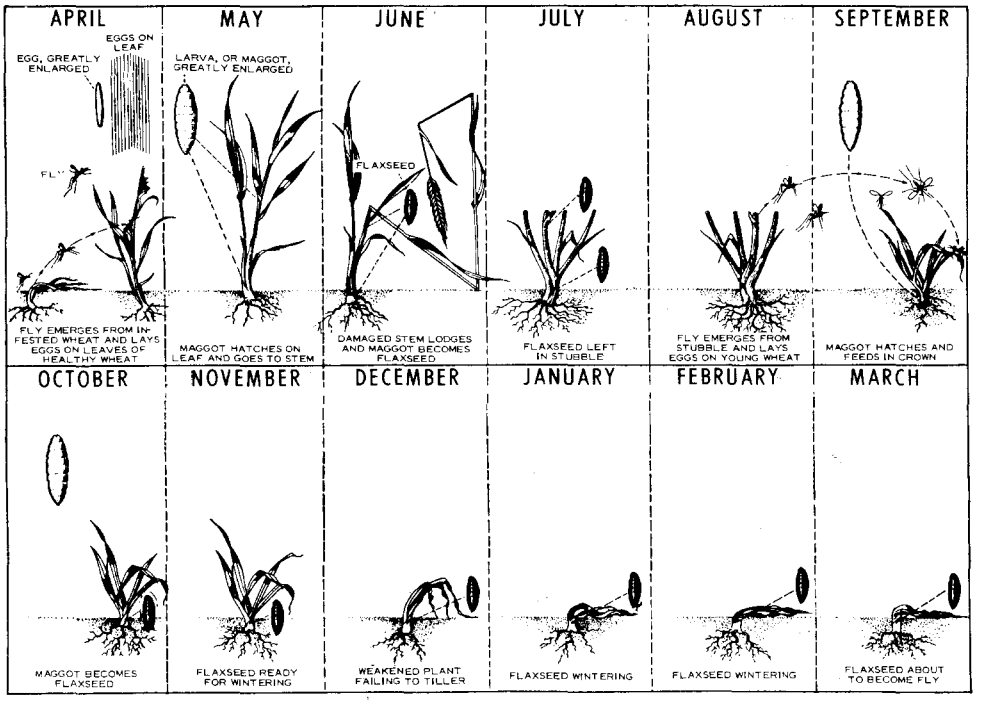


Figure 12. Seasonal development of the Hessian fly.

Research in South Dakota indicates that the yield impact is directly related to the time of infestation and the number of larvae per plant from the first brood and the number of larvae per stem with the second brood. Fall injury to winter wheat from Hessian fly resembles early season damage to spring wheat.

The adult Hessian fly prefers to lay its eggs on spring, winter, and durum wheat, with a preference being shown for spring wheat. Light infestations have been observed on barley, rye, and several grasses including bromegrass.

RESISTANT VARIETIES

Guard, released by South Dakota in 1983, is the only Hessian fly resistant hard red spring wheat available. It is a semi dwarf with above average yield, strong straw strength, medium early maturity, is resistant to stem and leaf rust, has a high test weight, low protein content, and has a poor quality rating.

CROP ROTATION

Rotate wheat (or other susceptible grain crops) with nonsusceptible crops such as oats, corn, sunflowers, flax, soybeans, safflower and legumes.

DELAYED PLANTING

Planting date of hard red spring wheat has no effect on the Hessian fly.

TILLAGE

Moldboard plowing in the fall after the first killing frost, or early in the spring before fly emergence, helps to suppress adult populations.

NATURAL CONTROL

At least three species of parasitic wasps are known to attack the Hessian fly in South Dakota, yet only relatively low levels of parasitism have been observed. A total of 35 parasitic species have been recorded from North America. Heavy parasitism of Hessian fly by parasitic wasps has occurred in the Pacific Northwest states but cannot be counted on to consistently control the fly populations.

CHEMICAL

Insecticides currently registered as planting time treatments for Hessian fly control include phorate 20% granules for both hard red spring wheat and winter wheat and disulfoton 15% granules for winter wheat only.

Application of the granular insecticides can be made through a properly calibrated grass seeder attachment or approved granular applicator attachment for grain drills. These granular insecticides should not be directly mixed with the seed in the drill box. Plastic tubes should be extended from the grass seeder or granular applicator into the drill spcuts so that the granules drop directly into the seed furrows.

Phorate 20% G should be applied at 1.2 oz of formulated product per 1,000 feet of row for any row spacing (minimum 8 inch spacing) at planting time or disulfoton 15 G at 1.7 oz of formulated product may be applied per 1,000 feet of row at 7 or 8 inch row spacing for Hessian fly control.

Do not feed or graze foliage treated with phorate for 45 days after application. Foliage treated with disulfoton should not be fed or grazed within 30 days of treatment.

Read, study, and follow all other label restrictions and precautions regarding the use and handling of these insecticides.

ACKNOWLEDGMENTS

The authors want to gratefully acknowlede the suggestions, input and help provided by Dr. Michael J. Weiss in the development of this circular. Thanks is also expressed to Dr. Carl Fanning and Dr. William S. Ball for their helpful review suggestions.

Summary of Management Practices for Wheat Stem Sawfly, Wheat Stem Maggot and Hessian Fly.

Management Practice	Insect		
	Wheat Stem Sawfly	Wheat Stem Maggot	Hessian Fly
Resistant Varieties	Cutlass, Glenman Leader, Tioga Lew, Fortuna, Lancer	None	Guard
Rotation with Non-Susceptible Crop	Yes	Yes	Yes
Delayed Planting	Yes - with susceptible variety	Yes	No
Tillage	Fall-shallow Spring-shallow	Fall or Spring	Fall-after frost Spring-early
Natural Control	Parasitic Wasps	Parasistic Wasps	Parasistic Wasps
Chemical	None	None	phorate 20G (hard red spring and winter wheat) Disulfoton 15 G (winter wheat only)

Helping You Put Knowledge To Work

NDSU Extension Service, North Dakota State University of Agriculture and Applied Science, and U.S. Department of Agriculture cooperating. Robert J. Christman, Interim Director, Fargo, North Dakota. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. We offer our programs and facilities to all persons regardless of race, color, national origin, religion, sex, disability, age, Vietnam era veterans status, or sexual orientation; and are an equal opportunity employer.

1500-12-94

E680